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STUDIES IN INDIAN TOBACCOS

No. I. THE TYPES OF *NICOTIANA RUSTICA*, L
YELLOW FLOWERED TOBACCO

BY

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I. INTRODUCTION.

YELLOW-FLOWERED TOBACCO (*Nicotiana rustica*, L.), is widely cultivated in India and is found principally in Eastern Bengal and Assam, Bengal, the United Provinces, the Punjab, and also in Kashmir. In some Districts of the Punjab and also in Purnea it is said to be supplanting the cultivated forms of *N. tabacum*, L., while it is the prevailing species in the damper soils of the southern portion of the tobacco-growing District of Rangpur. This species is hardier, requires a shorter time to come to maturity and is said to give a higher yield than *N. tabacum*. So little is known of this tobacco in India that it is stated that no different races of the species exist.¹

The area occupied by the tobacco crop in India is estimated by Watt at 1,100,000 acres. The total annual value, at £5, or Rs. 75 per acre, is considered by Coventry² to exceed five million pounds sterling, which would bring tobacco into the fifth or sixth position of importance among the crops of India.

¹ Watt, *The Commercial Products of India*, 1908, pp. 797 & 798.

² Coventry, *Proceedings of the Board of Agriculture in India*, 1906 p. 77.

The first step in the improvement of Indian tobaccos was necessarily the study of the various races at present cultivated in the country. The material for this work was obtained from a large collection of Indian tobaccos growing on the Púsa Farm in 1907. This collection was made in 1905 and our selections were made from the second generation of Púsa-grown plants. All the types, both of *N. tabacum* and also of *N. rustica*, were selected in 1907 and have been grown in pure culture in the Botanical Area at Púsa for the last two seasons.

The objects of the work are threefold :—

1. The study of the varietal characters and the amount of variation in the Indian types of tobacco.

2. The isolation and growth in pure culture of all the constant forms obtained and the determination of the best types in cultivation. By this means seed of definitely described types is now for the first time available for variety trials and also for hybridization work. We have already found that the value, both as regards yield and quality of leaf, of the various types of *N. rustica* varies very considerably. It appears exceedingly likely that by the cultivation of the best of the pure types already isolated, a considerable improvement in the crop would at once result. The quality of the various types is still under investigation and will be dealt with in future papers.

3. The study of the inheritance of characters in tobacco and the production of new and improved races.

The present paper contains an account of the work so far done on *N. rustica* with regard to 1 and 2. The results obtained in the case of *N. tabacum* and also in tobacco breeding will be described in subsequent papers.

Since the publication of Dunal's enumeration of the species of the genus *Nicotiana*¹ in 1852, a monograph on the same subject by Comes² has appeared. This author has reduced Dunal's 58 species to 41 and has considerably altered the sections *Tabacum*

¹ De Cándolle, *Prodromus*, XIII, 1, 1852, p. 556.

² Comes, *Monographie du genre Nicotiana*, Naples, 1899.

and *Rustica*. Comes considers that *N. rustica* has given rise, on account of the very different climatic conditions under which it has been cultivated from time immemorial in the new world, to the following six varieties:—

1. Var. *texana*, Comes. This is said to be a native of Mexico and to be the first variety of tobacco introduced from Florida into Portugal. The *Calcuttya* tobacco, cultivated in India, is said by Comes to belong to this variety.

2. Var. *jamaciensis*, Comes. This variety seems to have been founded on herbarium specimens only and is said to be a native of Jamaica, Guatemala and Mexico. Nothing appears to be known, however, as regards the cultivation of this form for commercial purposes.

3. Var. *asiatica*, Schrank. This variety is grown in Syria, Arabia, Persia and Abyssinia, and is said to be the best snuff tobacco in cultivation.

4. Var. *brasilia*, Schrank. This variety is the one largely cultivated in Europe for the manufacture of snuff.

5. Var. *humilis*, Schrank. This variety also is said to be extensively cultivated for the manufacture of snuff.

6. Var. *scabra*, Comes. A native of South America of no commercial importance on account of its disagreeable odour.

A careful study of the descriptions of these six varieties and of the illustrations in Comes' monograph indicates that these varieties are by no means well marked. Further, when it is remembered that natural cross-fertilization can easily take place between the various races, it is not difficult to understand that the limits of the varieties would quickly be lost.

On attempting to refer the Indian forms to the above varieties, difficulties were at once encountered. The majority of the types in cultivation at Púsa do not resemble any one variety, but possess characters, some of which agree with one of Comes' varieties and the others with one or more of the remaining varieties. Furthermore, the Indian types form a series, and even if broken up into classes, there are intermediate forms which may with equal justice be placed in either of two groups. It appeared

more desirable therefore to arrange the Indian forms in classes, than to attempt to refer them to the six varieties above. Later, it is hoped to obtain the cultivated forms of this species from other countries and to compare them with the indigenous types.

II. THE METHODS EMPLOYED IN RAISING THE EXPERIMENTAL PLANTS.

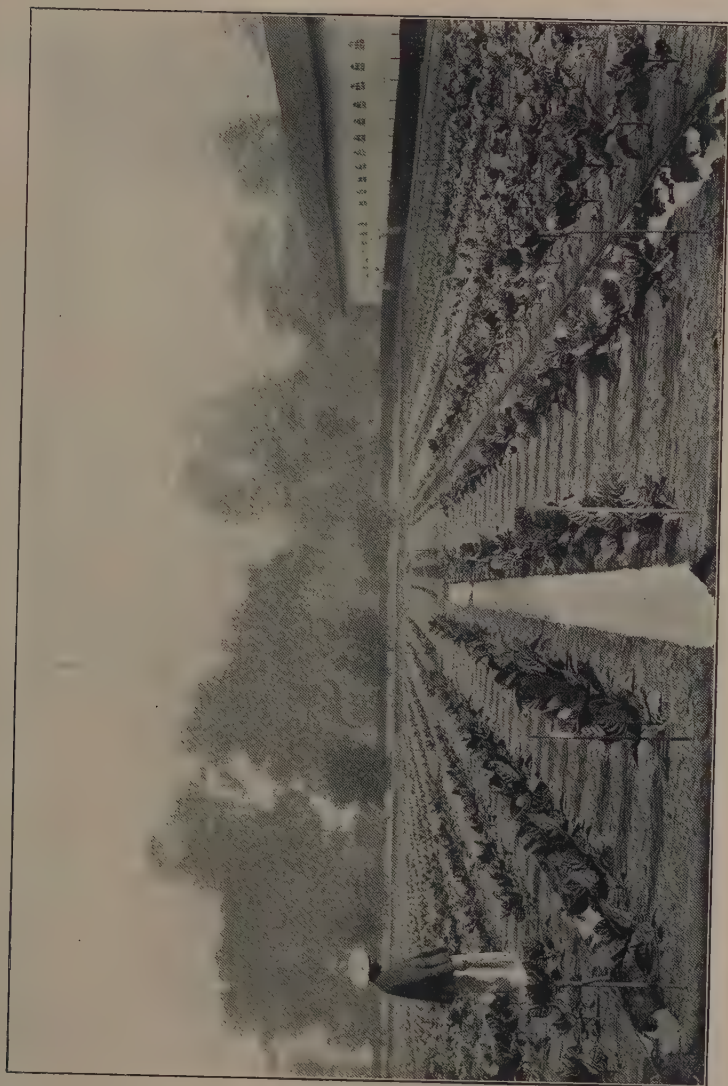
THE cultivation of *N. rustica* in India follows closely that practised in the case of the allied species, *N. tabacum*. In Bihár, high-lying well-manured fields are selected for this crop and the land is kept fallow after the previous *rabi* harvest and continually cultivated. In some districts, hardly any rotation is practised, tobacco following tobacco for several years on the same land. The seeds are sown in raised nurseries, to prevent flooding by rain, after the end of the monsoon and the seedlings, when about 3 inches high, are planted out in the field, about 12 to 18 inches apart each way and rather closer together than in ordinary tobacco. Transplanting is done in the late afternoon, the young plants are watered for a few days and covered, during the heat of the day, with leaves until they are established.

After this, two objects are kept in view : (1) the land is kept free from weeds and continually surface-cultivated with the *khurpi* or hand-hoe ; and (2) the tobacco plants are prevented from wasting their energies in the production of suckers and flowers. When the plants are about 18 inches high, the tops are broken off and a small skewer is inserted at the fracture and pushed a little way down. The ryots believe this has the effect of dwarfing the plant and prevents it throwing out more suckers. Each topped plant bears eight to ten leaves, which constitute the crop. The plants are cut down as a whole in February and cured in the country fashion. The object of the ryot is to grow as large a quantity as possible of coarse, strong tobacco. Quality is not considered, and such operations as priming are not carried out.

The study of the characters of the tobacco plant in the field and their inheritance is beset with special practical difficulties. Much has been said in the literature on the marked variation

produced in tobacco by the soil and the general climatic conditions both on the quality of the crop and also on the form of the plant. It is clear that in order to obtain reliable evidence on the characters of the plant, and also on the inheritance of these characters, one of the first conditions is to prevent any possible contamination of the cultures.

The first difficulty experienced in growing a large number of pure cultures is concerned with the raising of the seedlings. As mentioned above, the ryots grow their seedlings in raised seed beds. This, however, is clearly impracticable in the case of several hundred cultures. In the first place, the seeds of tobacco are so small that they might be carried from one bed to another by wind, earthworms, rain or by careless workmen. In the second place, some of the seeds would not germinate when sown, but would come up during the following years, thereby contaminating the land for subsequent nurseries. The vitality of tobacco seed is well known and in the United States the seed is often kept several years. At Púsa, in 1905, some tobacco was allowed to go to seed in one of the fields, and a certain amount of seed found its way into the soil. Every year stray seedlings have been noticed on this site and also on land at a lower level which receives the surface drainage of the field in question. The practice adopted at Púsa is to raise the seedlings in large boxes and every precaution is taken to collect the earth and leaf mould from places where contamination by stray tobacco seed is impossible. The boxes are made up about six weeks before sowing and kept moist so as to cause any chance seeds to germinate. So far no tobacco seedlings have been found in the boxes prior to sowing. The boxes are sown one at a time and the sower has to wash his hands before sowing another box. After sowing each box it is immediately removed to the shade of trees till the seedlings appear and up to planting time the boxes are enclosed in a wire netting fence to keep off animals and are watched day and night. Precautions are taken during the process of thinning to prevent admixture. The boys who do this work have to wash their hands after finishing each box, as otherwise a few ungerminated seeds



FURROW-IRRIGATION AT PUSA.

might be carried to other cultures. After transplanting, the soil in the boxes is thrown away and the boxes washed. These precautions have proved successful and in no case has any mixture of the cultures been discovered.

The second difficulty in growing the experimental cultures is met with in transplanting. It is the usual custom in Bihár to plant out the seedlings in the afternoon, to immediately water them and to cover the plants with leaves during the hottest part of the day until they are established. Numerous losses result and it is necessary to fill up the vacancies with fresh plants. With many hundreds of experimental cultures it is obvious that even if every care is taken there is a possibility that in a few cases plants from the wrong box might be taken, and mixed cultures obtained. Even if no mixing took place, the replacement of dead plants leads to unevenness in the rows. These transplanting difficulties were successfully overcome by the adoption of a system of furrow irrigation. After the final preparation of the field, furrows about 18 inches wide and 4 inches deep are laid off at the proper distance, so that there will be a furrow between alternate rows of tobacco (see Plate I). These furrows are then filled several times from a distributing channel which runs at right angles to the rows. The water percolates laterally and soon the soil is well moistened between the furrows. Transplanting is now carried on in the soil, moistened by lateral seepage from the trenches, and the young plants are covered with *nim* (*Melia indica*) leaves during the day which are removed at night. No direct watering is necessary at planting, so the formation of a hard lump of soil round the plant resulting from direct watering is avoided. The check due to transplanting by this method is very small and the plants quickly establish themselves. The loss due to transplanting in 1908 at Púsa, a year of exceedingly short moisture, was about 1 in 200. Most of the losses took place where very few seedlings were available and where consequently very small plants had to be used. It was found, however, that these small plants could be efficiently protected by placing over them small perforated earthen saucers which kept off grasshoppers,

and also had the effect of forcing the plants. Any subsequent watering required by the crop is done by filling the trenches.

During the last three years at Púsa our experimental tobaccos have been grown under furrow irrigation with marked success over the methods adopted by the ryots. The advantages of this method of watering by lateral seepage, are largely bound up with the question of tilth. Wherever tobacco is grown, the importance of a well cultivated and well ærated soil has been emphasised, and it has frequently been laid down that this is the first condition for successful tobacco-growing. Badly cultivated and poorly ærated soil always lead to disaster. The surface rooting habit of tobacco and the exceedingly rapid growth of this crop both demand a proper condition of the soil which would be difficult with surface irrigation. Lateral seepage is so slow that the tilth is not destroyed, and it is also the most economical method of supplying moisture as the loss by evaporation is reduced to a minimum.

The system of furrow irrigation described above might with advantage be adopted in general cultivation. The tobacco crop is an exceedingly valuable one in India and great care is taken by the cultivators in raising it. Its welfare in Bihár to a great extent depends on the *rabi* sowing rains, known as the *hathia*, which fall at the end of September and in the early part of October. These showers, however, are precarious and it is not uncommon for the monsoon to come to an end early and to be followed by rainless hot weather in September and October. Under these circumstances a large number of the young transplanted tobacco seedlings die off and others are devoured by grasshoppers and cut worms. Many plants have to be replaced and a very uneven crop is obtained, resulting in loss of maturity at harvest time. It would not be difficult to completely ensure the crop in dry years by furrow irrigation from wells.

III. POLLINATION AND NATURAL CROSS-FERTILIZATION.

POLLINATION.

THE method of pollination in *Nicotiana rustica* has been studied by several observers. Comes¹ considers this species to be self-fertile. Fruwirth,² who obtained good setting under nets, states that self-pollination takes place as the flowers open. This is brought about by the bursting of the four long stamens over the already receptive stigma. After the flowers open, the stamens elongate and are lifted still further above the stigma. Fruwirth and Comes consider, however, that cross-pollination is also possible by means of insects. It appeared therefore that the mode of pollination normally occurring in this species, is self-pollination in the bud brought about by the position of the bursting anthers just above the receptive stigma and that cross-fertilization is rare.

While studying the various Indian types of this species at Púsa, it was observed that in type I some of the flowers dropped off after the fading of the corolla and very few capsules naturally set seed. In this row practically no seed was obtained under bag in the ordinary way. On examining the buds it was found in nearly all cases that the styles were much longer than the stamens and often protruded beyond the still closed bud. Type I had therefore long styled flowers, and it was found necessary in this case to artificially self-fertilize the flowers in order to obtain seed under bag.

It now appeared desirable to examine the flowers of the other types of this species. It was found that the anthers always

¹ Comes, *Rendiconto della Reale Accademia delle Scienze fisiche e matematiche di Napoli*, Feb. 1879.

² Fruwirth, *Die Züchtung der landwirtschaftlichen Kulturpflanzen*, Bd. III, 1906, s. 89.

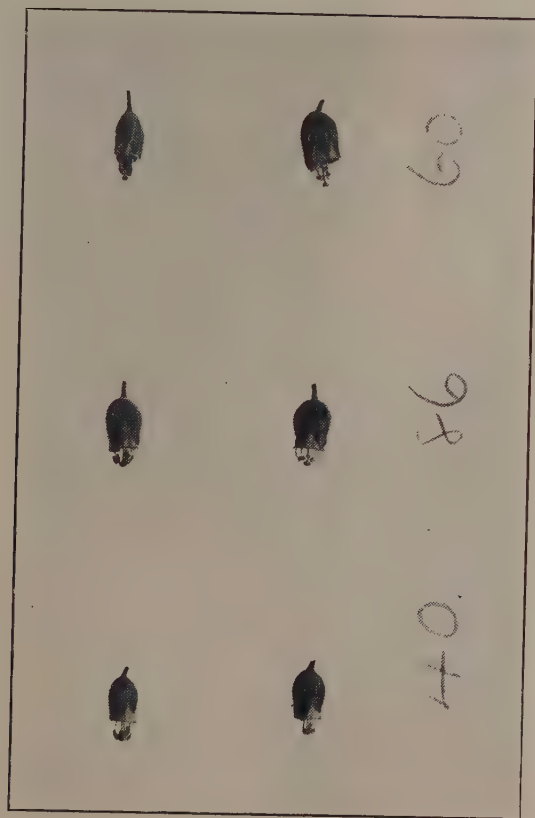
burst in the bud before the corolla opens and that the stigma is receptive at the same time. Homogamy is therefore the rule. The relative position of the stigma and anthers, however, was found to vary considerably between the various types. The general scheme was found to be as follows. The anthers just before the flowers open are either below, opposite or above the stigma, and in all cases they bend towards it. When the pollen is shed, the style elongates and lifts the stigma a little. Then the corolla begins to fade and the anthers recede from the stigma. Every gradation was found in the various types between the condition in which the stamens were above the stigma throughout, rendering cross-pollination practically impossible, and the other extreme case in which all the stamens are so much shorter than the style that self-pollination is only possible by insects or by wind shaking the flowers. Many small bees were noticed visiting the flowers, and some small flies, covered with pollen, were observed inside the corolla tubes. The arrangements for pollination in the various types can be divided into the following three classes (Plate II) : —

Class I.—Stamens much longer than the style.

In this class the style is decidedly shorter than the stamens, so that the four longest stamens bend over the stigma, and in an open flower the stigma is not visible, being always covered by the stamens. In such flowers cross-pollination is almost impossible, and this condition was found in types V and XV.

Class II.—Stamens about the same length as the style.

This class includes the various conditions intermediate between classes I and III, and comprises the majority of the types. The stamens may be a very little longer than the style, so that about half the anther projects above the stigma and the latter in the opened flower is surrounded by the burst anthers, but is not obscured by them as in class I. This condition is found in types XIII and XIV. In other cases the tip of the anther only may project above the stigma and the pollen is deposited round its edge



SHORT, INTERMEDIATE AND LONG-STYLED FLOWERS.

just before the corolla opens, while in the fully-opened flower the empty anthers are clustered round the style just below the stigma. In a few types the anthers may just touch the stigma and the pollen is deposited at its extreme edge or else beneath it. In such cases the anthers are sometimes rather late in bursting and very little pollen is shed before the flower opens.

It is clear that very small differences in the length of the stamens would produce any of these three conditions, and it is not surprising to find that a certain amount of difference can sometimes be found in the flowers of the same plant. For instance, in plants where the anthers normally just touch the stigma, it is usual to find some flowers in which they escape touching it. Thus, in some flowers cross-pollination would be more favoured, in others self-pollination.

Class III.—Style much longer than the stamens.

This extreme condition in which the stigma grows out of the unopened bud into the air and in which self-pollination is exceedingly difficult was only met with in type I. In this type and also in types VI, VII and VIII very few capsules naturally set seed, and it was only possible to obtain seed under bag by artificial selfing.

These observations point to the likelihood of the frequent occurrence, under Indian conditions, of natural cross-fertilization in the field when the types are grown next to next. That natural crossing actually does take place under these circumstances was proved in a large number of cases.

NATURAL CROSS-FERTILIZATION.

During the year 1905 a collection of Indian tobaccos was made by the Púsa Farm, and the sowings were made the same year. A few plants of each sowing were allowed to run to seed without being bagged, and this seed was again sown in the autumn of 1906. In 1907, we selected seed from all the different plants that could be found in these sowings, and the seed from each plant was sown separately by us the same year. Opportunities for natural cross-fertilization at Púsa were therefore possible for two seasons, 1906 and 1907, before we took

over the work. As only few of the plants, however, were allowed to flower in both years, these opportunities were not numerous. Cross-fertilization, although previously possible in the various tracts of India from which the seed was collected, is not likely to be of frequent occurrence on account of the fact that but few plants are allowed to run to seed by the ryots and that the fields of *N. rustica* are very scattered. In 1908, it was found that out of 45 rows of *N. rustica*, each grown from the seed of one plant, 9 were not uniform but contained plants differing from the rest. In 1908, a large number of these aberrant plants were bagged as well as the parent seed plants selected from the uniform rows. The seeds of these plants were again sown separately the same year. In every case the aberrant plants proved to be crosses and gave rise to the most diverse forms (Plate III). In one case infertile plants, with peculiar foliage which may possibly be hybrids between *N. rustica* or *N. tabacum*, were observed (Plate IV). The selected plants from the uniform rows, however, bred true. Natural crossing is therefore frequent in many types of this species, and it will always be necessary in experimental work to obtain seed under bag. No diminution in vigour in the self-fertilized seed obtained under bag has been noticed by us during the past two years. The uniformity of the rows obtained from bagged seed is remarkable. Fruwirth,¹ who grew this species for three years in Germany from selfed seed, did not observe any lack of vigour in the offspring compared with that from free flowering plants. He states :—“ Ein Zurückstehen der Pflanzen aus derart gewonnenen Samen gegenüber solchen, welche aus Samen frei abgeblühter Pflanzen erwachsen waren, konnte ich nicht feststellen. Auch die dritte Generation bei ständigem Einschluss war nicht merkbar geschwächt.”

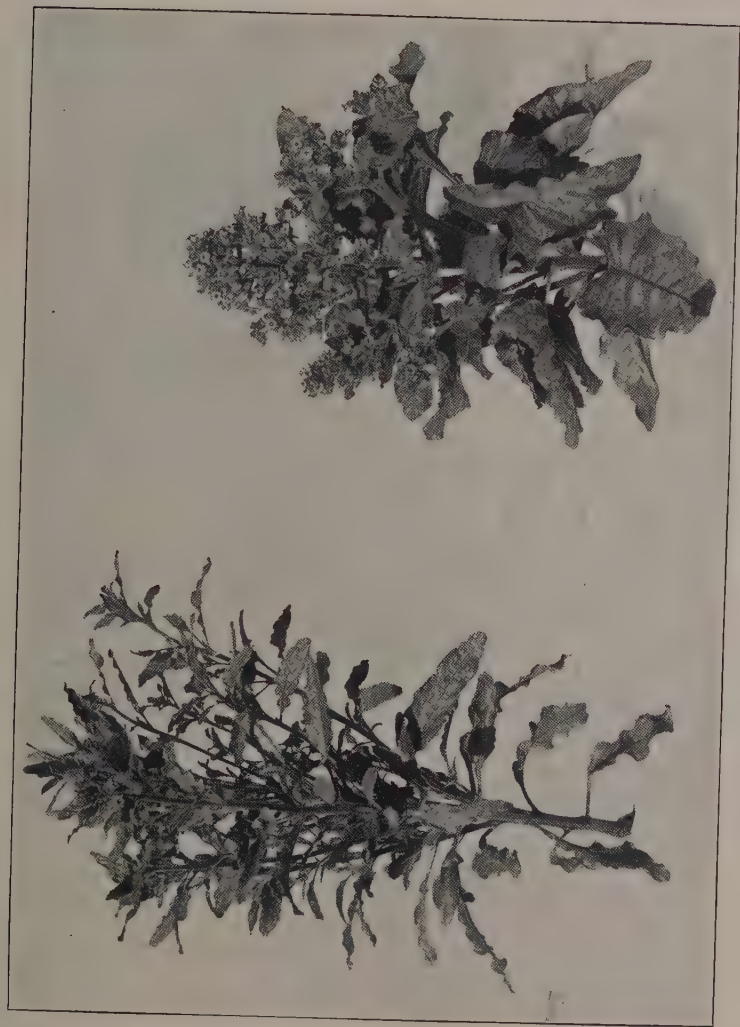
THE PRODUCTION OF SELF-POLLINATED SEED.

The production of selfed seed under bag in this species offers no particular difficulty. Large waterproof bags are desirable,

¹ Fruwirth l. c.



THE PROGENY OF A SELF-POLLINATED ABERRANT PLANT.
AN EXAMPLE OF NATURAL CROSS-FERTILISATION.



A SECOND EXAMPLE OF NATURAL CROSS-FERTILISATION.

and we have found it best to thin out the main inflorescence very considerably by cutting off the very young buds as well as the opened flowers and capsules before the bag is placed in position. In this way, only buds which would naturally open during the next two days are bagged, and self-pollination rapidly takes place. Bagging should not be left too late in the season as the later flowers on the main inflorescence and most of those on side shoots do not set seed readily. All suckers and side flowering branches are removed at the time of bagging and the whole energy of the plant is utilised in the production of selfed seeds. The bags are removed as soon as all the corollas have faded, and the capsules are allowed to ripen in the air. The bags should on no account be left on too long as this leads to the falling of the capsules. These are counted at the time the bag is removed and indicated by a label which is tied on the stem just below the lowest bagged capsule. Any flower buds which arise above this point, as well as any others on the rest of the plant, are carefully removed from time to time. Unless this is done with great care, the new buds grow rapidly and set seed. The capsules may either be collected as they ripen or else the bag can be replaced when they begin to turn brown. The ripe capsules of this species do not drop off so easily as is the case in some of the races of *N. tabacum*, and this second bagging is therefore not so necessary.

While the above procedure gives satisfactory results in most of the Indian types of this species, it is not successful in the long-styled forms. Practically no seed is obtained under bag with these forms. In such cases the method has to be modified. The unopened buds are bagged and the fully-opened flowers are artificially selfed and the bag replaced. In this way only can good setting be obtained.

The seeds are thoroughly dried in the sun in bags and stored either in bottles or preferably in air-tight cases with a little calcium chloride during the monsoon. They retain their germinating power for several years.

IV. CLASSIFICATION AND DESCRIPTION OF THE TYPES.

MORPHOLOGICAL CHARACTERS.

The study of the characters of this group of tobaccos is not an easy matter. We have to deal with a plant which adapts itself in the most remarkable and intimate manner to the method of cultivation, to the available moisture and to the food materials in the soil, giving rise, according to circumstances, to every gradation of crop from small starved specimens to rank overgrown plants. The types, however, breed true even to the most minute morphological characters. In order to appreciate the differences between the types it is best to study them in normally developed specimens such as are produced when the supply of moisture and manure is carefully regulated. Another difficulty lies in expressing accurately on paper the differences between the various types. The differences are principally of degree only and are largely bound up with the habit of the plant and the characters of the leaves such as the tone of colour and texture. Many of these differences are too subtle to be expressed by an ordinary botanical description, and to appreciate them thoroughly it is necessary to study the plants themselves grown side by side.

(a) *Habit*.—The differences in habit of the types are due to the length of the internodes and also depend on the inflorescence, which may be raised well above the leaves or contracted. The height of the plants, of course, varies with the general condition of nutrition. In the 1909 crop, the height of the smallest type was 59 cms., that of the tallest 142 cms. The measurements are taken after the early capsules are formed. The habit is the most distinctive character of the type, but one that is difficult to describe adequately. It is well seen in the photographs.

(b) *Leaves*.—The general shape of the leaves of all the types grown is very much the same throughout. They are always petiolate, vary in shape from subcordate to orbicular and are usually slightly asymmetric. The average length of the petiole varies from 5.5 to 9 cms. The average length of the lamina varies from 18.5 to 34 cms. and the ratio length/breadth from .98 to 1.19. These measurements, taken on the 1909 crop, are only of relative value. The margin is generally undulate, but the amount of undulation varies and in some of the types the margin is flat and entire. The apex varies from acute to rounded. The surface of the leaf may be flat or variously puckered, and the texture, which is generally thick and coarse, is much finer in some of the types. The colour is usually dark bluish-green, but lighter green and even yellowish-green leaved types occur. After the habit, the surface, texture and colour of the leaves are the characters of greatest value in distinguishing the races. The angle of insertion of the leaves varies considerably and helps to give each type its characteristic appearance. The leaves of the inflorescence are much smaller than the lower leaves and in the bushy types are merely small editions of these. The ground leaves, as a rule, are much smaller than the rest of those on the lower part of the plant and soon dry up. These were left out of consideration and the measurement made on the third and fourth of the typical leaves. The large lower leaves pass by various stages to the small leaves of the inflorescence.

(c) *Inflorescence*.—The inflorescence varies from the open and elongated type by every gradation to very compact and crowded cauliflower-like forms. In the open elongated inflorescences the flowers are often sparsely arranged; in the compact ones the flowers are very closely packed.

(d) *Flowers*.—The flowers of this species do not appear to have been studied in any great detail. Considerable differences between the flowers of the various Indian types have been observed both as regards the size and form of the various parts. As regards the size of the flowers, the length with one exception is practically the same in all and only varies from 18 to 20mm. The

diameter, however, varies considerably and three classes can be distinguished :—

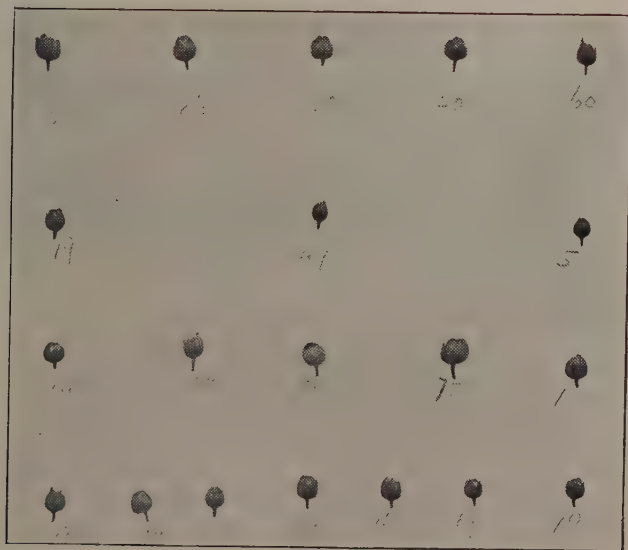
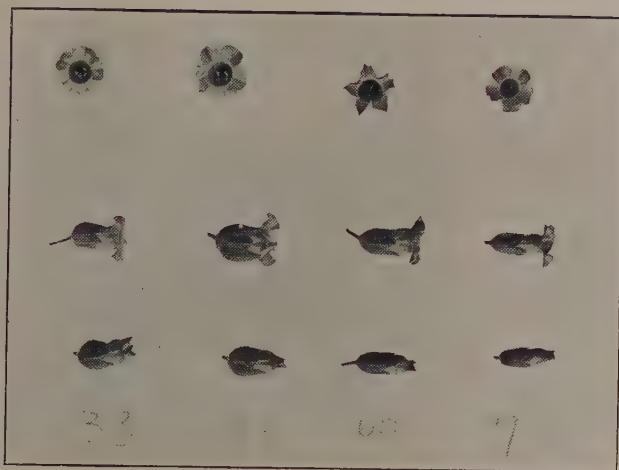
1. Slender flowers in which the maximum diameter of the calyx is 10mm. or less. The buds of these narrow flowers are very pointed.

2. Medium flowers in which the diameter varies from 11 to 14mm.

3. Broad flowers in which the diameter is 15mm. or more. In these the calyx is loose and baggy, and the diameter is about 2mm. more than the corolla, and to this is due the peculiar appearance of the flowers of this class.

Calyx.—The relative length of the calyx and corolla varies. The persistent gamosepalous calyx has five teeth, the posterior one of which is always longer than the rest. The remaining four are more or less uneven. The length of the teeth as well as their shape varies. They may be short and obtuse or long and somewhat acute. As a rule, the midrib of the sepals is inconspicuous, but in type I it is well marked as a dark green ridge. In shape the calyx varies from tubular to globular. In the former case the flower has a straight appearance, while in the latter there is a distinct median constriction. In some types the calyx is exceedingly loose and baggy and has a much greater diameter than the corolla.

Corolla.—The general appearance of the limb of the corolla as seen in the front view of the fully-opened flower varies. It may be either quite flat and sometimes also reflexed, in which case the lobes are generally somewhat rounded, or it may never be fully expanded, in which case the lobes may be ovate, very distinct and with the edges curved inwards, or the limb may present a wavy, undulating appearance which has been shortly designated as “crumpled” in the descriptions of the types given below. The outline of the limb varies. The divisions between the petals may be very small, a condition usually found when the limb is flat, or the lobes may be rounded and more strongly marked or the limb may be still more deeply cut when the lobes are more or less pointed. There is an apical point to the petals which is much



FLOWERS AND CAPSULES.

more marked in some types than in others, but it is not visible in the front view in cases where the limb is flat as the margin is generally recurved. In the description of the types this condition is described by the term "apiculæ inconspicuous."

In plate V are represented flowers showing the variations in the structure described above. In No. 33 (type II) the calyx is globular, the teeth short and obtuse, the flower medium in size with a median constriction, and the corolla limb flat and very slightly divided. In No. 83 (type XVIII) the flower is large, the calyx loose and baggy and the corolla limb crumpled. In No. 60 (type I) the flower is medium in size, with no median constriction, the calyx is tubular with long, acute teeth and prominent midrib, while the corolla limb is deeply divided and not fully expanded. No. 19 (type VIII) is an example of a slender flower. The difference in the shape of the buds is well seen.

All gradations between the extreme cases figured in plate V are found among the various types, and the determination of the character of the flower is a matter of some difficulty. The later flowers are seldom really typical and are always much smaller, while many flowers with slight abnormalities in the corolla are found.

Capsule.—The capsules vary considerably in size. Types VI & VII have the smallest capsules (Nos. 49 & 5 on Plate V) and type XVII (No. 75) the largest. The shape may be round as in type XVIII (No. 83), conical as in type V (No. 40), or cylindrical as in type XIII (No. 68). The apex may be rounded, blunt or somewhat pointed and may be more or less umbilicate. As will be seen from the plate, the extent to which the capsule is covered by the persistent calyx varies in the different types. There is a certain amount of variation on this point, though to a much smaller degree, in the capsules of each plant. Often the persistent calyx is split longitudinally by the expanding capsule.

SCHEME OF CLASSIFICATION.

In arranging the types in a provisional scheme the habit and the nature of the inflorescence have been used as differentiating

characters. The Indian types of *N. rustica* fall naturally into two groups which are easily distinguished in the field: (1) tall plants with open habit and long internodes: (2) short plants with short internodes. Further sub-division is more difficult as the plants in group (1) are all very much alike, while those in group (2) form an almost perfect series. The best division appears to be that based on the nature of the inflorescence which may be open with sparse flowers, somewhat open with flowers crowded, or compact with flowers crowded, giving classes A, B, C. The types within the classes are arranged in order, so that the first type of each class bears the most resemblance to the preceding class. It was generally a matter of some difficulty to decide in which class to place such transitional types. The types within the classes are separated from one another by differences in the arrangement of the leaves, shape, surface and colour of the latter.

I. Tall Plants with long internodes.

Types I, II, III, IV & V.

II. Short Plants with short internodes.

A. Habit open, inflorescence open, flowers not crowded.

- (1) Side shoots as long as the main axis, giving the plant a corymbose appearance.

Type VI.

- (2) Side shoots not as long as the main axis, giving the plant a pyramidal appearance.

Types VII & VIII.

B. Habit and inflorescence somewhat open but less so than in A, flowers crowded, leaves generally small or medium in size.

Types IX, X, XI, XII, XIII, XIV & XV.

C. Dwarf compact plants, internodes very short, inflorescence compact, flowers crowded, leaves large.

Types XVI, XVII, XVIII, XIX, XX.

DESCRIPTION OF THE TYPES.

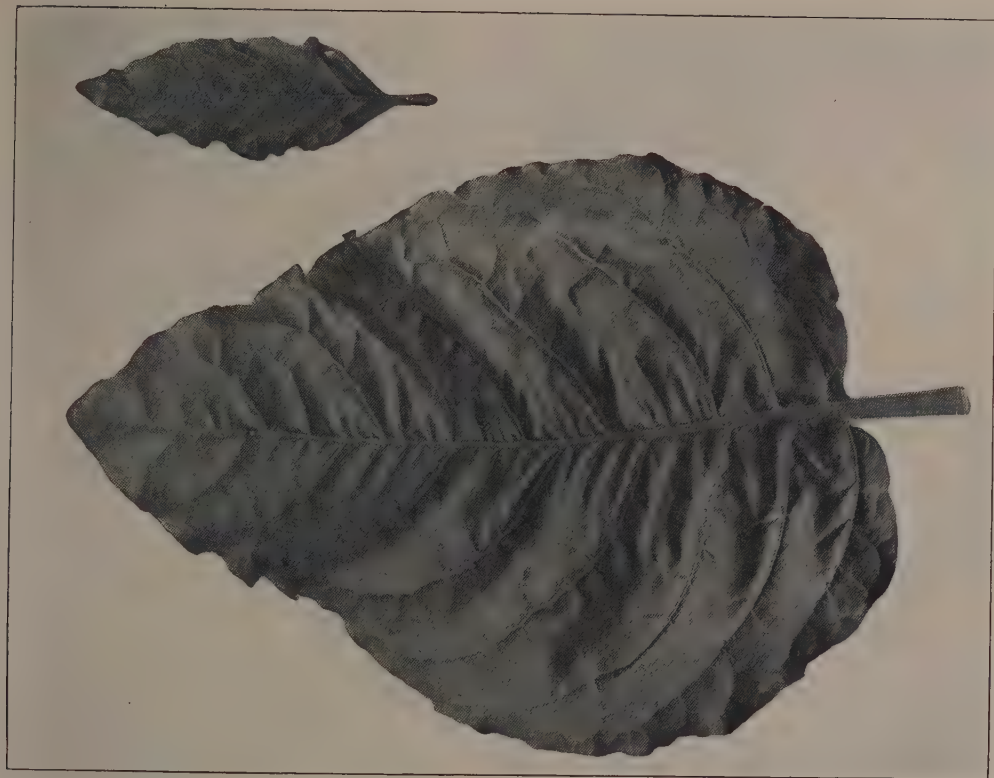
Group I. Tall plants with long internodes.

Five types (Nos. I to V) are comprised in this group which is well defined by the habit. The height of the plants is due to two factors: (1) the length of the internodes; (2) the open and extended nature of the inflorescence which forms nearly half the plant. Not only are the secondary branches of the inflorescence arranged in an open manner, but the flowers are somewhat distant from one another. Types I to IV are about the same height (135 to 142cms.), but type V, although agreeing in habit with this group, approximates in height somewhat to types VI & VII of the next group.

Types I & V are easily differentiated from the rest, the former by the shape of its leaves and structure of the flower; the latter by its height, small leaves and shape of the inflorescence leaves. Types II, III & IV are much alike, especially III & IV. Type II may be distinguished from the other two by the slenderness of the plant, flatness of the leaves and habit of the inflorescence. Type IV is later, coarser and stouter than type III.

Type I. Plants early ; height 135cms. *Leaves* inserted at an angle of about 60° , the lamina afterwards curving towards the ground, subcordate ; apex more acute than in the other types of this group ; margin very undulate and curving upwards ; surface somewhat puckered ; colour dark blue-green ; average length of petiole 7cms. ; average length of lamina 29.5 cms. ; ratio length/ breadth = 1.13. *Inflorescence leaves* inserted at an angle of about 45° , elliptical to lanceolate ; apex acute ; margin undulate ; surface flat. *Inflorescence* open ; the secondary branches long and slender, almost as long as and running somewhat parallel to the main axis. *Flowers* sparse, medium in size ; outline straight, no apparent constriction. *Calyx* somewhat dark green, tubular ; midrib of sepals well marked ; teeth long and pointed. *Corolla* with very distinct lobes ; limb never flat and fully expanded ; apiculæ conspicuous. *Capsule* medium in size, a little longer than the calyx, round ; apex rounded, scarcely umbilicate.

This type is not adapted for self-fertilization (see p. 9). The stamens are shorter than the style throughout the period of development of the flower, and it is only by shaking or by the agency of wind that self-pollination can be effected. If left to themselves, many of the flowers drop and but few capsules are formed. Artificial pollination and crossing with another type were uniformly successful.



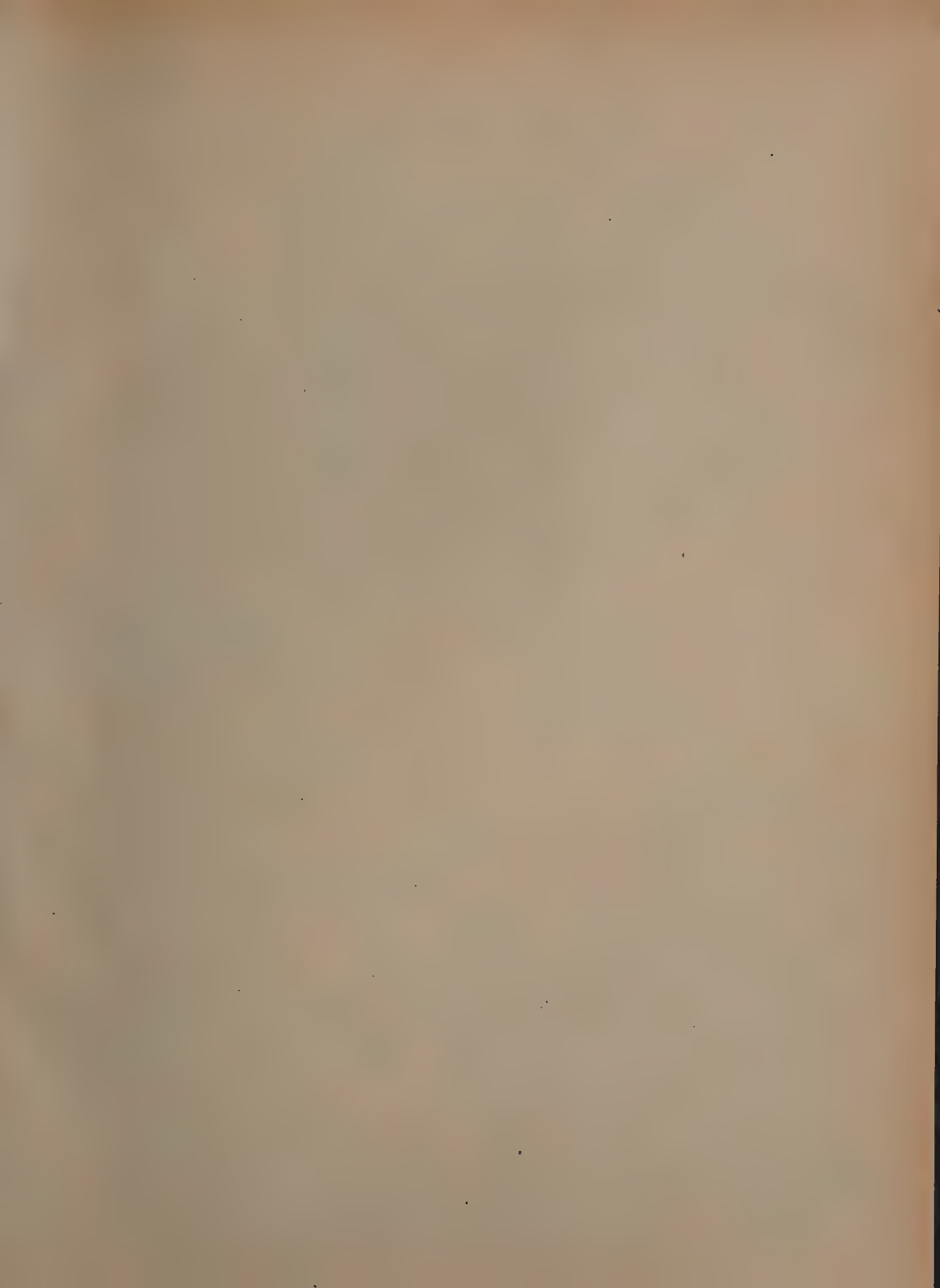
TYPE 1.



Type II. Plants very early; height 142cms. *Leaves* inserted at an angle of about 60° , subcordate; apex obtuse; margin slightly undulate; surface flat; colour blue-green; average length of petiole 7.5cms.; average length of lamina 25cms.; ratio length / breadth = 1.11. *Inflorescence leaves* inserted at an angle of about 45° , elliptical to lanceolate; apex somewhat obtuse; margin slightly undulate; surface flat. *Inflorescence* open; the secondary branches long and slender, almost as long as, and running somewhat parallel to, the main axis. *Flowers* sparse, medium in size; outline shows a decided constriction. *Calyx* yellowish green, globular, giving the appearance of a constriction in the outline of the flower; midrib of sepals inconspicuous; teeth short and obtuse. *Corolla* with a slightly divided limb which is quite flat and fully expanded; margins of the limb and apiculæ recurved. (Plate V, 33). *Capsule* medium in size, roundly conical, about two-thirds covered by the persistent calyx; apex rounded and umbilicate.

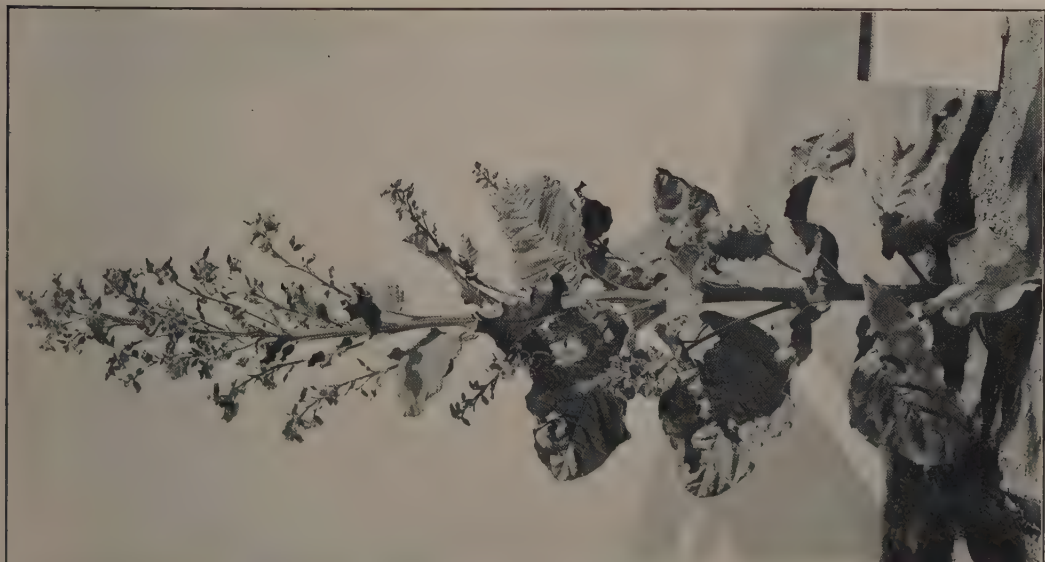
In the flowers of this type cross and self-pollination are both possible. When the anthers burst, the tip of the anther projects slightly above the edge of the stigma, so that the pollen is either deposited on the edge of the stigma or in the tube. When the flower opens and the stamens have shed most of their pollen, the burst anthers are clustered round the style below the stigma. Under bag this type sets very few seeds.





Type III. Plants early; height 137cms. *Leaves* inserted at an angle of about 45° , subcordate; apex obtuse; margin undulate; surface somewhat puckered; colour blue-green; average length of petiole 7cms.; average length of lamina 28.5cms.; ratio length/breadth = 1.13. *Inflorescence leaves* inserted at an angle of about 30° , ovate to elliptical; apex acute; margin undulate; surface puckered. *Inflorescence* open; the secondary branches long and slender, but not as long as, nor so parallel to, the main axis as in types I & II. *Flowers* sparse, medium in size; outline shows constriction but less markedly than in type II. *Calyx* somewhat light green, globular, but less so than in type II; teeth short and obtuse. *Corolla* with a slightly divided limb which is quite flat and fully expanded; margins of the limb and apiculæ recurved. *Capsule* medium in size, conical, about half covered by the persistent calyx; apex umbilicate and somewhat pointed.

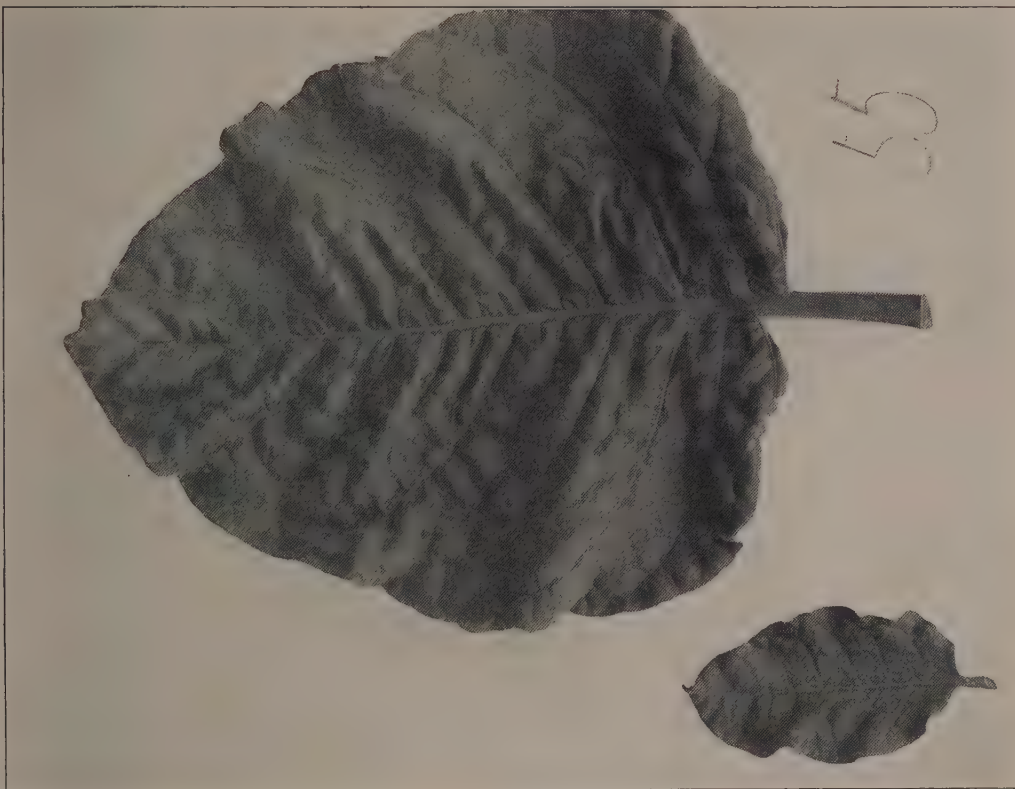
In this type the mode of pollination is the same as in type II. A slight abnormality was observed in many of the flowers, namely, the stigma projected between the lobes of the corolla in the closed bud.



Type IV. Plants late; height 135cms. *Leaves* inserted at an angle of 45° , subcordate; apex obtuse; margin undulate; surface more puckered than in type III; colour blue-green; average length of petiole 7cms.; average length of lamina 29.5cms.; ratio length/breadth = 1.05. *Inflorescence* leaves inserted at an angle of 30° , ovate to elliptical; apex obtuse to acute; margin slightly undulate; surface flat. *Inflorescence* open; the secondary branches long and slender, but not so long nor so parallel to the main axis as in types I & II. *Flowers* sparse, medium in size, but larger and coarser than in type III; no apparent constriction in the outline. *Calyx* loose and baggy; teeth short and obtuse. *Corolla* with distinct lobes, limb very crumpled; apiculæ inconspicuous. *Capsule* medium in size, roundly conical, about one-third covered by the persistent calyx; apex rounded, not markedly umbilicate.

The plants of this type are much stouter and coarser looking than those of the other types in this group.

In this type the anthers surround the stigma and both self- and cross-pollination are possible. Good setting is obtained under bag.



Type V. Plants early ; height 107cms. *Leaves* inserted at an angle of 60° ; subcordate ; apex obtuse ; margin undulate ; surface somewhat puckered ; colour blue-green ; average length of petiole 7cms. ; average length of lamina 24.5cms. ; ratio length/breadth = 1.09. *Inflorescence leaves* inserted at an angle of 45° , subcordate to ovate ; apex obtuse ; margin very slightly undulate ; surface flat. *Inflorescence* open ; secondary branches shorter than the main axis and not parallel to it. *Flowers* somewhat sparse, small in size ; outline shows a decided constriction. Calyx somewhat globular ; midrib of sepals fairly prominent ; teeth somewhat acute. *Corolla* with distinctly divided limb, which is quite flat and fully expanded ; apiculæ well marked. *Capsule* medium in size, conical, about two-thirds covered by the persistent calyx ; apex not umbilicate.

Type V is adapted for self-pollination. When the flower opens, the anthers are well above the stigma and completely cover it, making cross-pollination almost impossible (see Plate II, No. 40). Although undoubtedly belonging to group I, this type is more dwarfed than the other members of this group and forms transition between this and the next group.



TYPE 5.

GROUP II. SHORT PLANTS WITH SHORT INTERNODES.

This group includes the fifteen remaining types. The plants are all shorter than in group I and have shorter internodes. Although the different types included in this group vary considerably among themselves, nevertheless, in the field, the difference in habit between the plants of group I and those of group II is most marked. This group is sub-divided into three classes A, B and C according to the character of the inflorescence.

A. Habit open, inflorescence open, flowers not crowded. This class contains three types, VI, VII, VIII. The plants, though shorter than those in group I, still have a somewhat open habit with a moderate length of internode.

- (1) Sideshoots as long as the main axis-giving the plant a corymbose appearance.

Type VI.

- (2) Sideshoots not as long as the main axis-giving the plants a pyramidal appearance.

Types VII & VIII.

Both VII & VIII are small-leaved forms. They are differentiated partly by the habit. The sideshoots in type VIII are more spreading than in VII, and this difference in appearance is intensified by the difference in the angle of insertion of the leaves. Both these differences tend to disappear later if the plant is allowed to become overgrown and when the leaves lose some of their turgidity. There are also small differences in the individual characters of the lower and inflorescence leaves.

Type VI. Plants very early; height 91cms. *Leaves* inserted at an angle of 60 to 90°, later drooping towards the ground, subcordate; apex obtuse; margin undulate and curved upwards; surface flat and somewhat glossy; colour somewhat light green with comparatively fine texture; average length of petiole 8cms.; average length of lamina 25.5cms; ratio length/breadth = 1.08. *Inflorescence leaves* inserted at an angle of more than 60°, narrowly elliptical; apex obtuse; margin entire; surface flat. *Flowers* sparse, slender. *Calyx* somewhat globular; teeth somewhat acute. *Corolla* with slightly divided lobes; limb flat and fully expanded; apiculæ not very well marked. *Capsule* small, conical, almost covered by the persistent calyx; apex pointed, umbilicate.

This type is not well adapted for self-pollination. The stamens, when shedding their pollen, are shorter than the style, so that the tip either just touches the underside of the stigma or in some cases does not reach it at all. Artificial self-pollination is necessary to obtain pure seed. It will be seen that this type bears a general resemblance to type I in many points.

TYPE 6.





Type VII. Plants early ; height 99cms. *Leaves* inserted at an angle of 45 to 60° ; subcordate ; apex obtuse ; margin undulate ; surface puckered ; colour blue-green ; average length of petiole 7cms. ; average length of lamina 18.5cms. ; ratio length/breadth = 1.12. *Inflorescence* leaves inserted at an angle of 30°, elliptical ; apex somewhat acute ; margin undulate ; surface flat. *Inflorescence* open ; secondary branches and sideshoots not as long as the main axis. *Flowers* sparse, slender, longer than in any other type ; outline straight, no apparent constriction. *Calyx* tubular ; teeth somewhat long and acute. *Corolla* with a slightly divided limb which is flat and fully expanded ; apiculæ inconspicuous. *Capsule* small, conical, entirely covered by the persistent calyx ; apex blunt and slightly umbilicate.

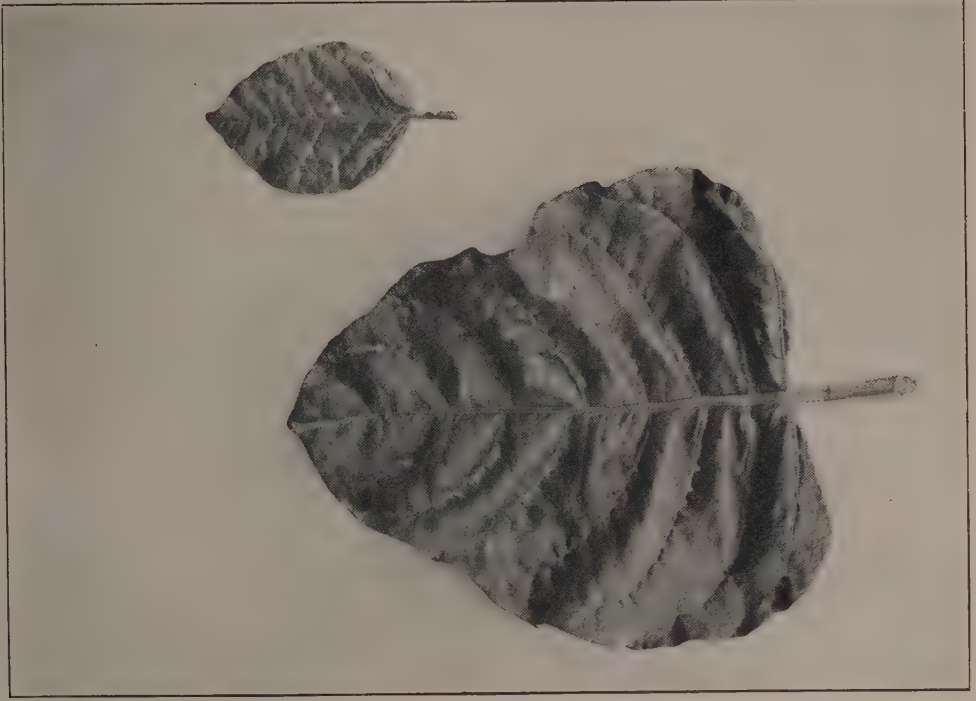
In this type both self- and cross-pollination are possible. The stamens are about the same length as the style, the tips of the stamens just projecting above the stigma when the anthers are shedding their pollen. The burst and empty anthers then cluster round the style underneath the stigma.



TYPE 7.

Type VIII. Plants early; height 82cms. *Leaves* inserted at an angle of more than 60° , subcordate; apex somewhat rounded; margin slightly undulate; surface slightly puckered; colour blue-green; average length of petiole 8cms.; average length of lamina 20cms.; ratio length/breadth 1.05. *Inflorescence leaves* inserted at an angle of 60° , broadly elliptical; apex somewhat acute; margin entire; surface flat. *Inflorescence* open; secondary branches and sideshoots not as long as the main axis. *Flowers* sparse, slender. *Calyx* tubular; midrib of the sepals fairly prominent; teeth somewhat long and acute. *Corolla* with very distinct lobes; limb never flat and fully expanded; apiculæ conspicuous. *Capsule* small, cylindrical, about two-thirds covered by the persistent calyx; apex blunt and umbilicate.

Pollination in this type takes place in the same manner as in type VII. In types VI, VII & VIII very few flowers set seeds when protected by bags and it was necessary to resort to artificial self-pollination.

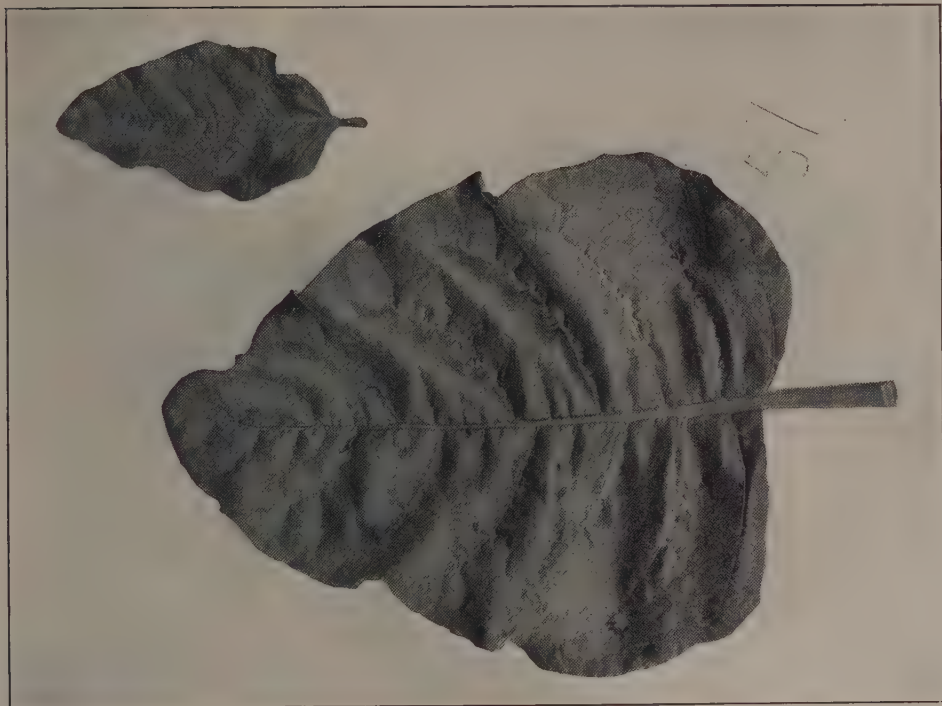


B. Habit and inflorescence somewhat open but less so than in class A, flowers crowded, leaves generally small or medium in size. This class contains seven types (IX to XV) and forms a series between plants with the habit of the last class and the compact dwarf plants of class C. There is a considerable variation both in the height (59cms. to 82cms.) and in the general appearance. Although the inflorescence is still somewhat open in character, the flowers on the individual branches are crowded and in most members of this class there is a distinct tendency towards the formation of a compact, crowded central portion of the inflorescence.

Type IX is a transition form between class A and this class. The inflorescence is fairly open. Types XI & XII are very much alike and only differ in small details. Type XII is less robust and shorter than XI and has smaller, thinner leaves. Type X is characterised by its bushy appearance and the light colour and flat surface of its somewhat small leaves. It is intermediate in habit between types IX & XI. Types XIII, XIV & XV are small-leaved forms. Type XIV is easily distinguished by its dwarf habit and by the horizontal arrangement of its leaves. Type XV is exceedingly bushy and the leaves appear more conspicuous than the inflorescence. Type XIII is in some respects a larger edition of type XIV.

Type IX. Plants very bushy and bear a large number of small leaves; height 88cms. *Leaves* inserted at an angle of nearly 90° , subcordate; apex obtuse to rounded; margin slightly undulate; surface almost flat; colour blue-green; average length of petiole 6.5cms.; average length of lamina 24cms.; ratio length/breadth 1.09. *Inflorescence leaves* inserted at an angle of about 90° , ovate to elliptical, there is a gradual transition in shape between the inflorescence leaves in this type; apex obtuse; margin slightly undulate; surface flat. *Inflorescence* fairly open; secondary branches and sideshoots spreading and not as long as the main axis. *Flowers* somewhat crowded, large. *Calyx* loose and baggy; teeth short and obtuse. *Corolla* with a slightly divided, flat limb; apiculæ inconspicuous. *Capsule* medium in size, somewhat rounded, almost covered by the persistent calyx; apex blunt, umbilicate.

Cross- and self-pollination are both possible in this type. The stamens are approximately equal in length to the style, the tips of the anthers just projecting above the stigma when the pollen is being shed.

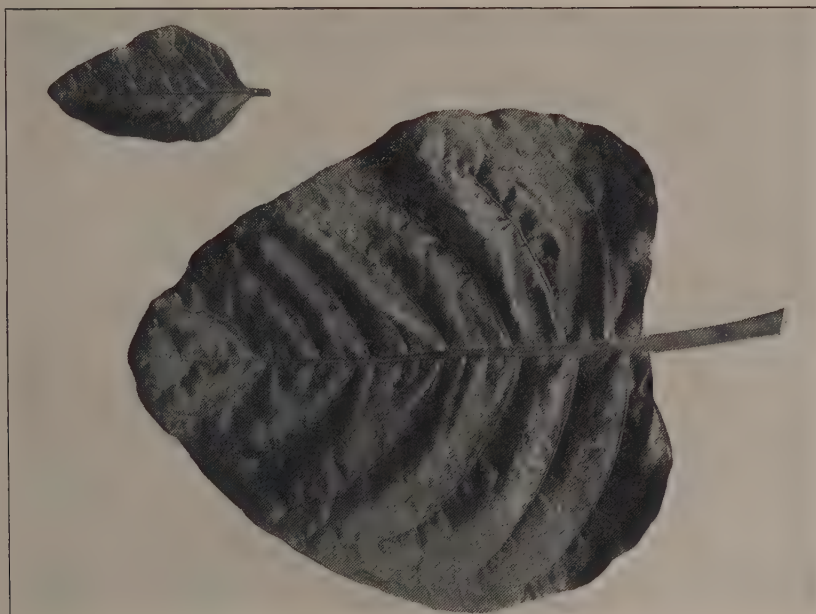


TYPE 9.



Type X. Plants bushy owing to the occurrence of larger leaves high up the stem and to the number of leaves, early ; height 70 cms. *Leaves* inserted at an angle of nearly 90° , subcordate ; apex rounded ; margin entire ; surface flat ; colour somewhat light green ; average length of petiole 8 cms. ; average length of lamina 22.5 cms. ; ratio length/breadth 1.07. *Inflorescence* leaves inserted at an angle of about 60° , elliptical ; apex obtuse ; margin entire ; surface flat. *Inflorescence* somewhat open ; sideshoots stout and spreading, not as long as the main axis. *Flowers* crowded, small. *Calyx* slightly globular ; teeth short and obtuse. *Corolla* with very distinct lobes ; limb not fully expanded or flat ; apiculæ well marked. *Capsule* small, conical, very long, more than two-thirds covered by the persistent calyx ; apex blunt and umbilicate.

Cross and self-pollination are both possible in this type as the stamens are approximately equal in length to the style. The leaves are thin and of comparatively fine texture.

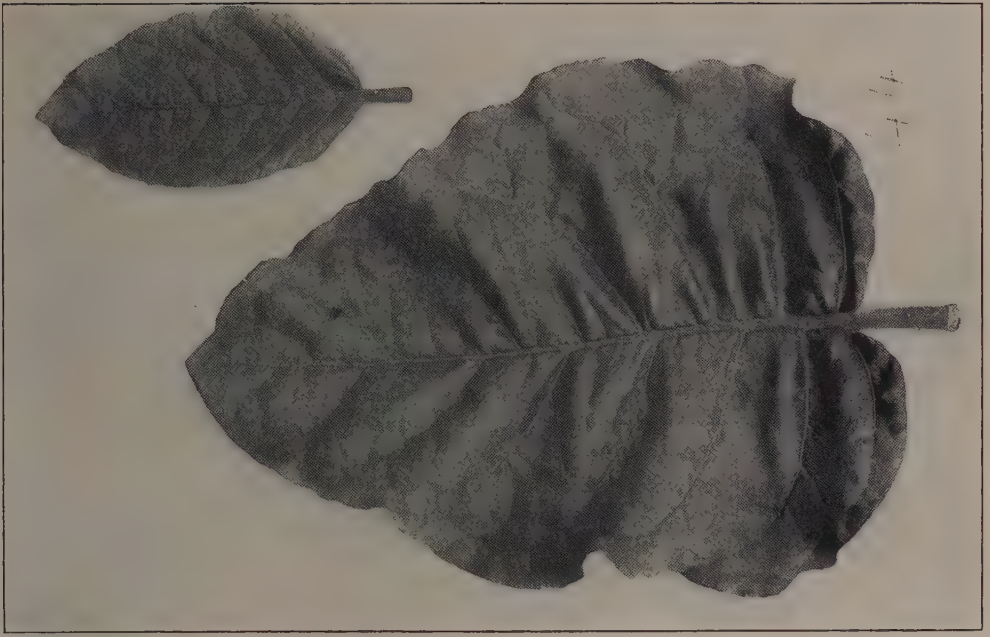


TYPE 10.



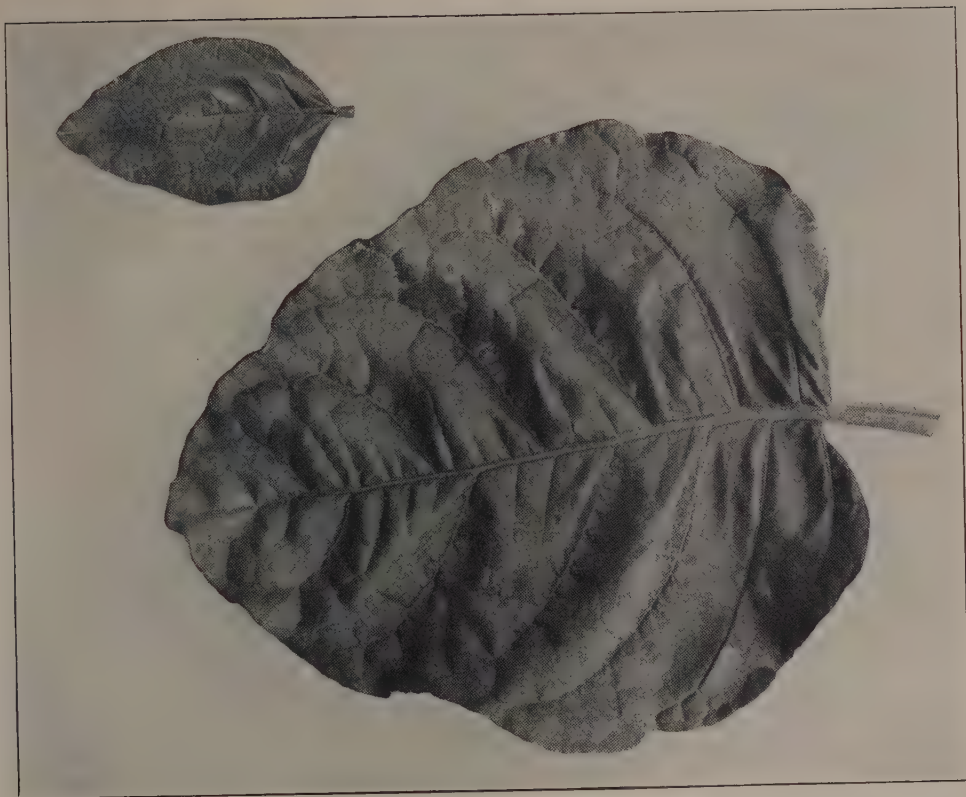
Type XI. Plants early but later than in type XII ; height 81cms. This type differs from types IX and XII in having the inflorescence raised well above the leaves ; height 71cms. *Leaves* inserted at an angle of 60° or more, subcordate ; apex obtuse to rounded ; margin slightly undulate ; surface almost flat ; colour dark blue-green ; average length of petiole 7 cms. ; average length of lamina 26cms. ; ratio length/breadth 1.17. *Inflorescence* leaves inserted at an angle of 60° , elliptical ; apex obtuse ; margin very slightly undulate ; surface flat. *Inflorescence* raised and somewhat open ; secondary branches not as long as the main axis. *Flowers* crowded, medium in size. *Calyx* very slightly globular ; teeth short and obtuse. *Corolla* with distinct lobes ; limb never flat or fully expanded ; apiculæ well marked. *Capsule* medium in size, conical ; half covered by the persistent calyx ; apex somewhat pointed and umbilicate.

Cross- and self-pollination are both possible in this type as the stamens and style are approximately equal in length.



TYPE 11.

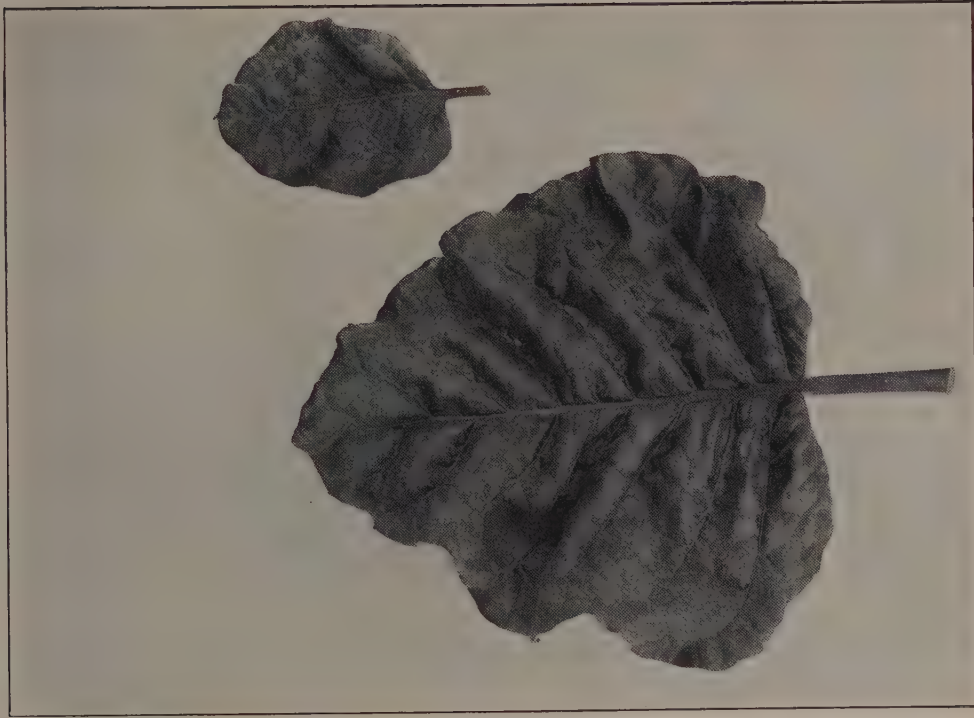
Type XII. Resembles type XI very closely, but is earlier, shorter and less robust, the leaves are smaller and thinner, the limb of the corolla is flat and fully expanded and the capsule less conical and with a blunter apex; height 71cms.; average length of petiole 6cms.; average length of lamina 25cms.; ratio length/breadth 1.09.



TYPE 12.

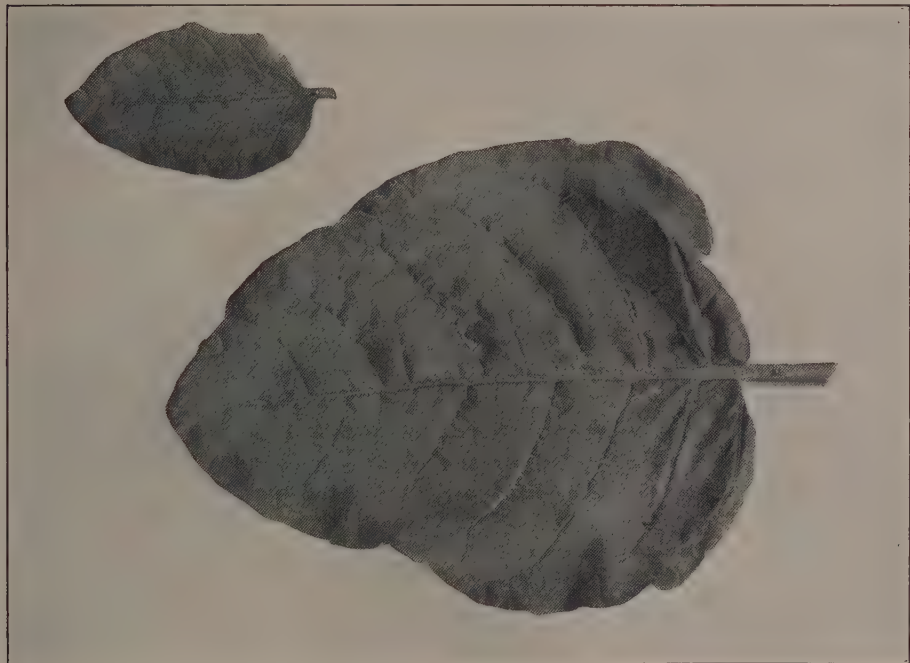
Type XIII. Plants early, bushy, bearing a large number of small leaves up the whole stem; height 79cms. *Leaves* inserted at an angle of about 60° or less, subcordate; apex rounded; margin very undulate; surface very puckered; colour very dark blue-green; average length of petiole 8cms.; average length of lamina 20.5cms.; ratio length/breadth .99. *Inflorescence leaves* inserted at an angle of 45° , broadly elliptical; apex obtuse to rounded; margin slightly undulate; surface slightly puckered. *Inflorescence* somewhat open; secondary branches and sideshoots not as long as the main axis. *Flowers* crowded, slender. *Calyx* tubular; teeth somewhat acute and leafy. *Corolla* with a slightly divided limb, somewhat crumpled; apiculæ not conspicuous. *Capsule* small, cylindrical, about two-thirds covered by the persistent calyx; apex blunt and umbilicate.

In this type self-pollination is predominant. The stamens are slightly longer than the style, so that when the pollen is being shed, the anthers are above the stigma for at least half their length, and when empty they cluster round the edge.



Type XIV. Plants early, very short; height 59cms. *Leaves* inserted at an angle of 90° ; subcordate; apex obtuse; margin very slightly undulate; surface flat; colour blue-green; average length of petiole 5.5cms.; average length of lamina 21.5cms.; ratio length/breadth 1.17. *Inflorescence* leaves inserted at an angle of 90° , elliptical; apex obtuse; margin entire; surface flat. *Flowers* slender, crowded. *Calyx* tubular; teeth short and obtuse. *Corolla* with very distinct lobes; limb never fully expanded or flat; apiculæ well marked. *Capsule* small, cylindrical, about two-thirds covered by the persistent calyx; apex blunt and umbilicate.

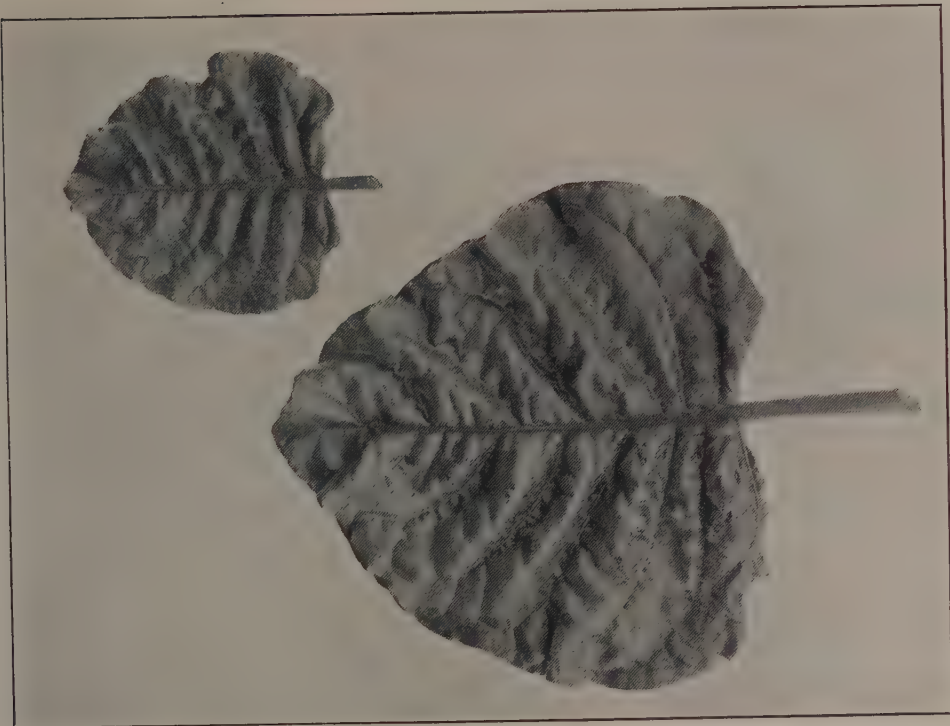
Pollination takes place in this type in the same manner as in type XIII.



TYPE 14.

Type XV. Plants late, very bushy partly owing to the comparatively large size of the inflorescence leaves ; height 82 cms. *Leaves* inserted at an angle of 45° , subcordate ; apex obtuse to rounded ; margin very undulate ; surface very puckered ; colour dark blue-green ; average length of petiole 9cms. ; average length of lamina 21cms. ; ratio length/breadth .98. *Inflorescence leaves* inserted at an angle of 30° to 45° and resemble the lower leaves in every way but are smaller. *Inflorescence* neither very compact nor very open ; sideshoots long but not as long as the main axis. *Flowers* crowded, slender. *Calyx* tubular ; teeth obtuse. *Corolla* with a very slightly divided limb which is flat ; apiculæ inconspicuous. *Capsule* small, rounded, almost covered by the persistent calyx ; apex blunt and not umbilicate.

In this type self-pollination is predominant, the stamens are raised well above the stigma and completely cover it when the flower opens and the pollen is being shed.



TYPE 15.

C. Dwarf compact plants, internodes very short, inflorescence compact, flowers crowded, leaves large. The chief characteristic of this group is the condensed form of the inflorescence. The compact central mass of flowers is sunk among the leaves, and although the inflorescence grows out later when the capsules form, most of the flowers open before this. The flowers are so closely packed that the operation of bagging is most difficult.

The five types contained in this class are easily differentiated. Type XVI is a transition form between classes B and C and might, with almost equal justice, be placed in either class. It is easily distinguished from the other members of this group by the colour, shape and surface of the leaves. Types XVII & XVIII are very vigorous forms with much puckered leaves. They are best differentiated by the shape of the leaves, those in type XVIII being shorter and rounder. The orbicular shape of the leaves in type XX is the best diagnostic character of this form.

Type XVI. Plants late; height 81cms. *Leaves* inserted at an angle of nearly 90° standing out horizontally from the stem subcordate; apex obtuse; margin flat; surface flat; colour light yellowish-green; average length of petiole 7cms.; average length of lamina 32cms.; ratio length/breadth 1.19. *Inflorescence* leaves inserted at an angle of 45° , elliptical; apex obtuse; margin entire; surface flat. *Inflorescence* opener than in the other members of this group. *Flowers* crowded, large. *Calyx* loose and baggy; teeth short and obtuse. *Corolla* with a very slightly divided limb which is flat and fully expanded; apiculae well marked. *Capsule* medium in size, round, almost covered by the persistent calyx; apex blunt and umbilicate.

In this type both cross and self-pollination are possible, the stamens being approximately equal in length to the style.



TYPE 16.

Type XVII. Plants very late ; height 63cms. *Leaves* inserted at an angle of 45 to 60°, subcordate, almost ovate ; apex rounded ; margin very undulate ; surface very puckered ; colour somewhat light green ; average length of petiole 9cms. ; average length of lamina 34cms. ; ratio length/breadth 1.05. *Inflor-escence* leaves inserted at an angle of about 60°, elliptical ; apex rounded ; margin very undulate ; surface very puckered. *Flowers* crowded, large. *Calyx* loose and baggy ; teeth short and obtuse. *Corolla* with a very slightly divided limb, which is crumpled ; apiculæ inconspicuous. *Capsule* large, somewhat conical, two-thirds covered by the persistent calyx ; apex rounded and umbilicate.

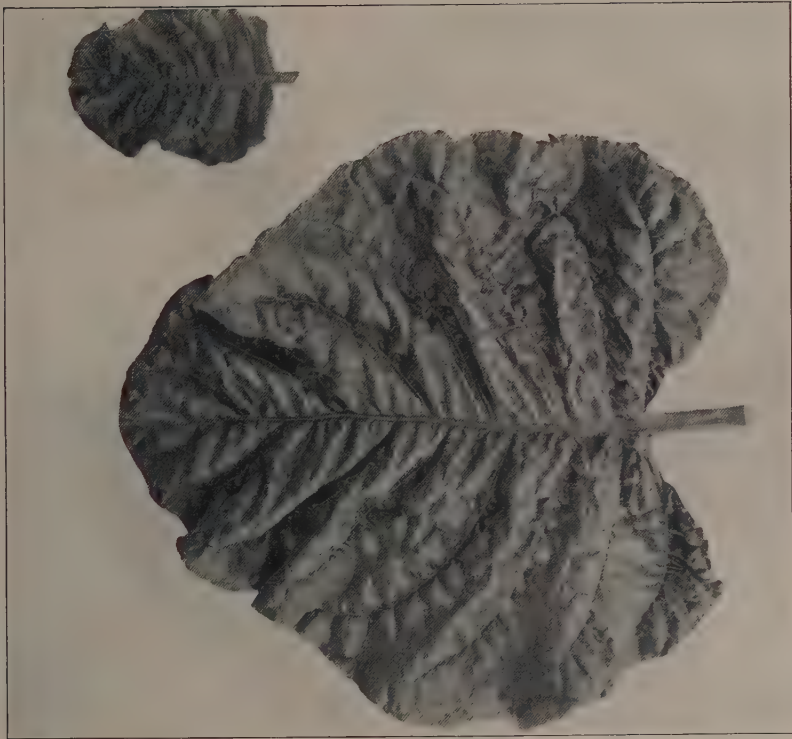
This type is adapted both for cross- and self-pollination, the stamens being approximately equal in length to the style.



TYPE 17.

Type XVIII. Plants late ; height 72cms. *Leaves* inserted at an angle of 45 to 60°, somewhat orbicular ; apex obtuse to rounded ; margin very undulate ; surface very puckered ; colour dark blue-green ; average length of petiole 9cms. ; average length of lamina 28cms. ; ratio length/breadth .97. *Inflorescence* leaves inserted at an angle of 45°, ovate or very broadly elliptical ; apex obtuse or rounded ; margin very undulate ; surface very puckered. *Flowers* crowded, large. *Calyx* tubular and loose ; teeth short and obtuse. *Corolla* with a slightly divided limb, which is flat and fully expanded ; apiculæ inconspicuous. *Capsule* large, round, almost covered by the persistent calyx ; apex blunt and umbilicate.

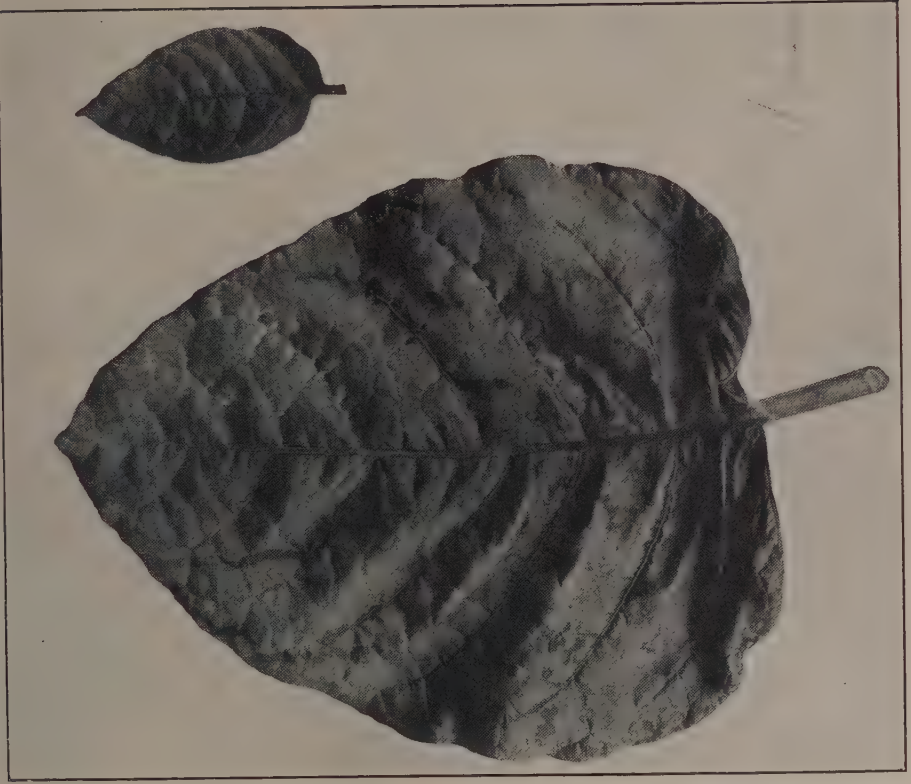
In this type both cross- and self-pollination are possible, the stamens being approximately equal in length to the style. This is a vigorous, very large-leaved type and is very like type XVII, but the leaves are shorter, more orbicular, darker green and thicker.



TYPE 18.

Type XIX. Plants early ; height 63cms. *Leaves* inserted at an angle of nearly 90° , subcordate ; apex obtuse ; margin very slightly undulate ; surface somewhat flat ; colour blue-green ; average length of petiole 8cms. ; average length of lamina 2.55cms. ; ratio length/breadth 1.08. *Inflorescence* leaves inserted at an angle of about 60° , elliptical ; apex somewhat acute ; margin entire ; surface flat. *Flowers* crowded, medium in size. *Calyx* somewhat globular ; teeth short and obtuse. *Corolla* with a very slightly divided limb which is flat and fully expanded ; apiculæ inconspicuous. *Capsule* small to medium in size, not quite round, almost covered by the persistent calyx ; apex blunt and umbilicate.

In this type self-pollination is somewhat favoured. The stamens are slightly longer than the style, the tips of the anthers projecting above the edge of the stigma when the pollen is being shed.



TYPE 19.

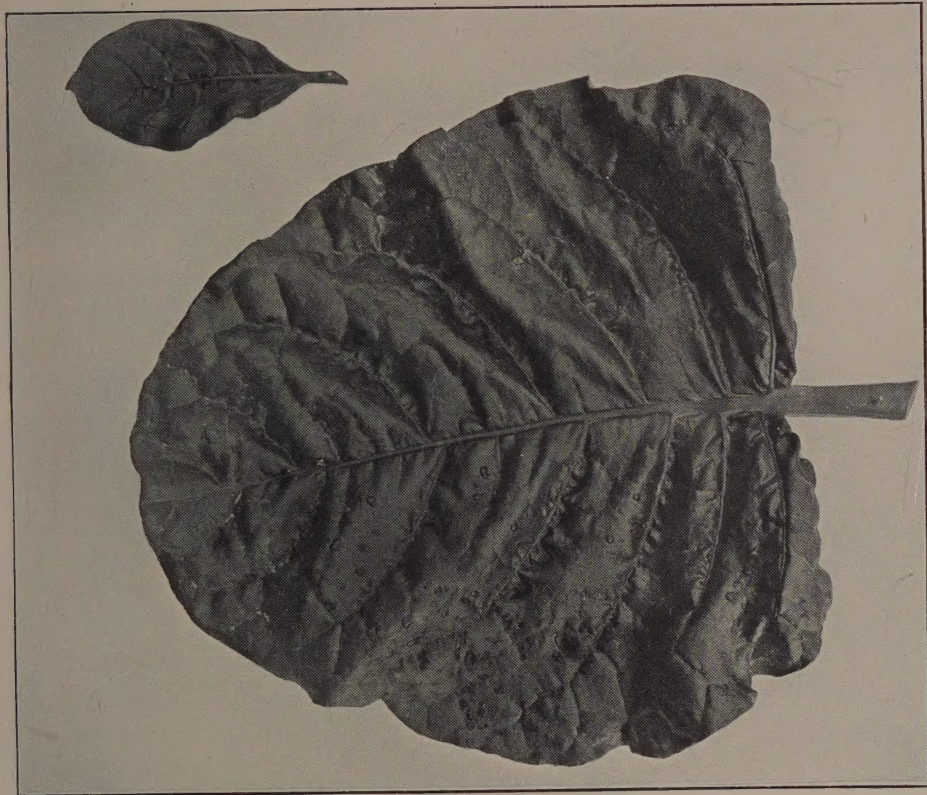
Type XX. Plants late; height 64cms. *Leaves* inserted at an angle of about 45° , almost orbicular; apex rounded; margin very slightly undulate; surface slightly puckered; colour dark blue-green; average length of petiole 7cms.; average length of lamina 25.5cms.; ratio length/breadth .93. *Inflorescence* leaves inserted at an angle of 30 to 45° , very broadly ovate; apex obtuse to rounded; surface flat; margin entire. *Flowers* crowded, large. *Calyx* tubular and loose. *Corolla* with a slightly divided limb which is flat and fully expanded; apiculæ inconspicuous. *Capsule* medium in size, round, almost covered by the very leafy calyx; apex blunt and umbilicate.

Cross- and self-pollination are both possible in this type, the stamens being approximately equal in length to the style.

AGRICULTURAL RESEARCH

INSTITUTE, PUSA;

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TYPE 20.



